

MORASH, MELANIE

From: Baylor, Katherine
Sent: Tuesday, December 31, 2013 10:43 AM
To: MORASH, MELANIE
Subject: Vapor Intrusion documents
Attachments: Lee AEHS VI R9 Study - Mar 16, 2010.pdf; sub-slab-soil-gas-variability-report.pdf

Melanie –

Attached please find the RARE vapor intrusion .pdf we just discussed. Also, I have attached my (short) paper on variability in sub-slab soil vapor, which is posted on Clu-in:

http://www.clu-in.org/issues/default.focus/sec/Vapor_Intrusion/cat/Site_Investigation_Tools/

I look forward to working with you on R9 vapor intrusion issues-
Kathy

Katherine Baylor, PG
U.S. Environmental Protection Agency
75 Hawthorne Street, WST-5
San Francisco, CA 94105
415-972-3351
baylor.katherine@epa.gov

EPA Region 9's "RARE" Opportunity to Improve Vapor Intrusion Indoor Air Investigations

EPA Update on Vapor Intrusion Workshop
AEHS Annual Conference, San Diego, California
March 16, 2010



EPA Region 9

Alana Lee
Kathy Baylor
Penny Reddy
Matt Plate

What's RARE?

Regional Applied Research Effort (RARE) and Purpose of Our Study

- Regional/ORD collaborative research projects designed to meet regional needs
- Vapor intrusion listed as a priority in EPA Region 9 Regional Science Plan
- Improve the methods for assessing vapor intrusion and indoor air quality in practical, cost-effective and health protective manner

Disclaimer: Mention of trade names or commercial products does not constitute endorsement or recommendation by EPA for use.



Practical, Cost-Effective, Health Protective, Scientifically Sound considering

- Multiple lines of evidence approach
- Traditional indoor air sampling methods (canisters)
 - high quality and quantitative, but relatively expensive and logistically complicated
- Longer time-integrated samples to reflect
 - potential exposure
 - account for ventilated and non-ventilated conditions to assess vapor intrusion into building

3



Region 9's "RARE" Study...

Assess three vapor intrusion assessment methods into individual buildings:

- Radon as a surrogate for VOC vapor intrusion
- Sorbent-based methods for longer time-integrated measurement of VOCs (3 types)

(This presentation focuses on results of passive sorbents)

- Pressure differential measurements (indoor/outdoor or indoor/subslab)

4



First Study Location: Orion Park Housing Area, Moffett Field, CA

Orion Park Housing Area

NASA Ames Research Center

U.S. Highway 101

5



Orion Park

- TCE in shallow groundwater (5-10 feet bgs)
- TCE groundwater concentrations (10 – 300 ug/L)
- Interbedded sand, silt and clay (Bay Mud)

Orion Park Housing Description



- Vacant former military housing constructed in 1968
- Units approximately 1200 sf (600 sf on two floors).
- 8 – 10 units share a common slab and walls

7

Phase 1 Experimental Setup (20 units)

PFT source deployment (air exchange)

14-day CAT (air exchange)

14-day temperature / humidity

14-day passive sorbent (tube-style thermal desorption)

14-day passive sorbent (radial solvent extracted)

14-day passive sorbent (radial thermal desorption)

14-day electret radon

4-day radon

4-day radon

4-day radon

TO-15 SIM

TO-15 SIM

8



Phase 2 Experimental Setup (8 units)

PFT source deployment (air exchange)

7-day CAT	7-day CAT
14-day temperature / humidity	
7-day active TO-17	7-day active TO-17
14-day passive sorbent (radial solvent extracted)	
14-day passive sorbent (radial thermal desorption)	
14-day electret radon	

4-day radon

4-day radon

TO-15 SIM

TO-15SIM

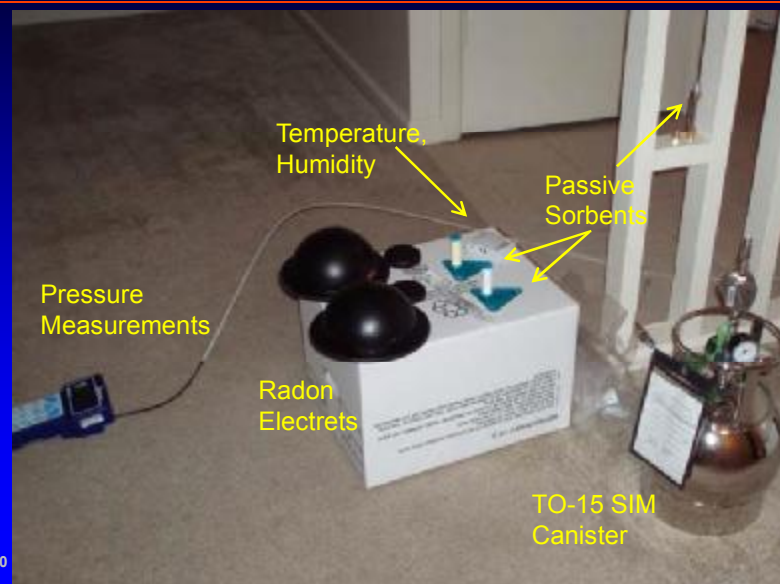
★ Grab subslab gas
★ (4 probes/unit)

★ Grab subslab gas
★ (4 probes/unit)

9



Phase 1 Experimental Setup (20 units)



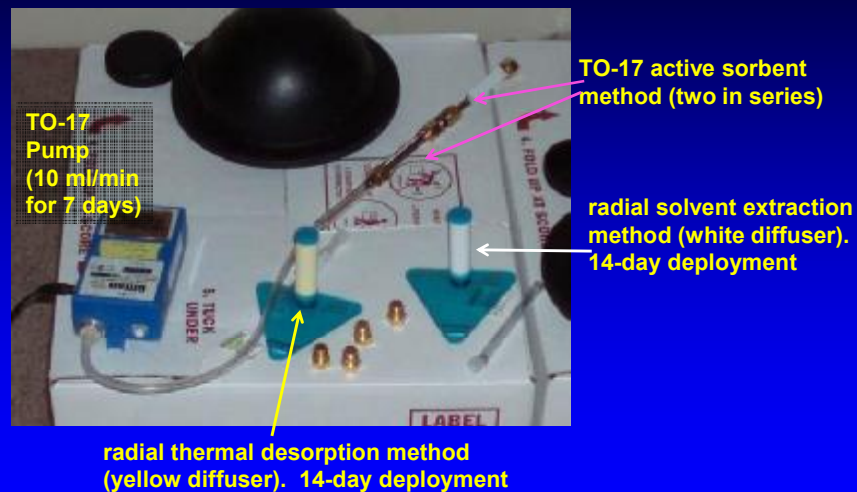
10



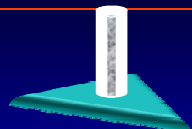
Phase 2 Setup (8 housing units)



Passive & Active Sorbents

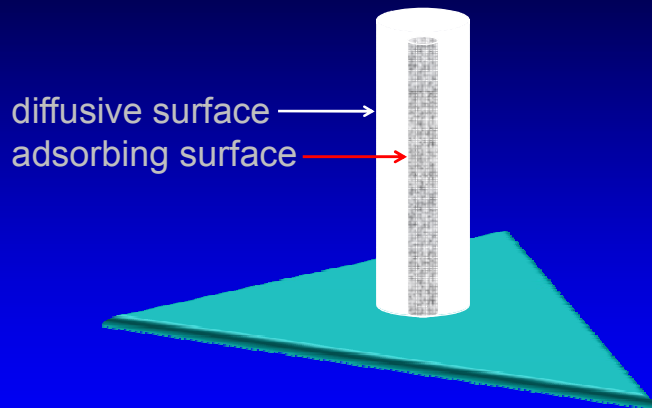


Indoor Air Sampler Comparison



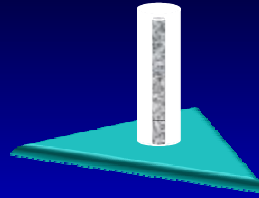
Canister (TO-15 SIM)	Sorbent
Need to consider deployment time and specific analyte list	Need to consider sorbent type, sorbent geometry, and deployment time frame for specific analyte list
Shorter time-integrated air sample (generally 8- 24 hours)	Longer time-integrated air sample (generally 2-14 days)
Relatively higher cost	Relatively lower cost
Logistically challenging to deploy (bulky, more expensive to ship)	Easy to deploy (small, compact, inexpensive to ship)
Very visible – homeowners cautious	Less intrusive - Better homeowner acceptance
Quantitative – low detection limits	Quantitative – low detection limits

Radial Passive Sorbents - Principle



Sorbent Concentration Calculation

$$C = \frac{m}{Qt} \times 1,000,000$$



C = concentration in ug/m³

m = mass of analyte in ug

t = exposure time in minutes

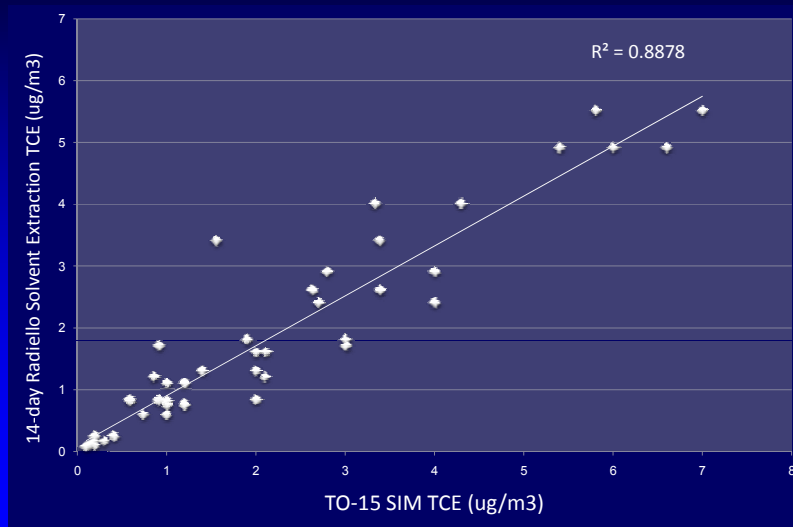
Q = experimentally measured sampling rate (ml/min)

(varies by chemical; listed on manufacturer-supplied data sheet)

15

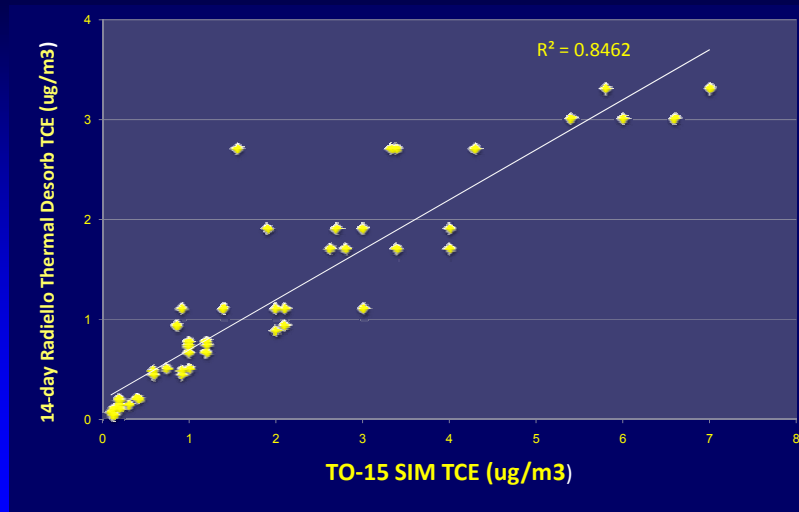


Radial Solvent-extract Sorbent vs. TO-15 SIM



16

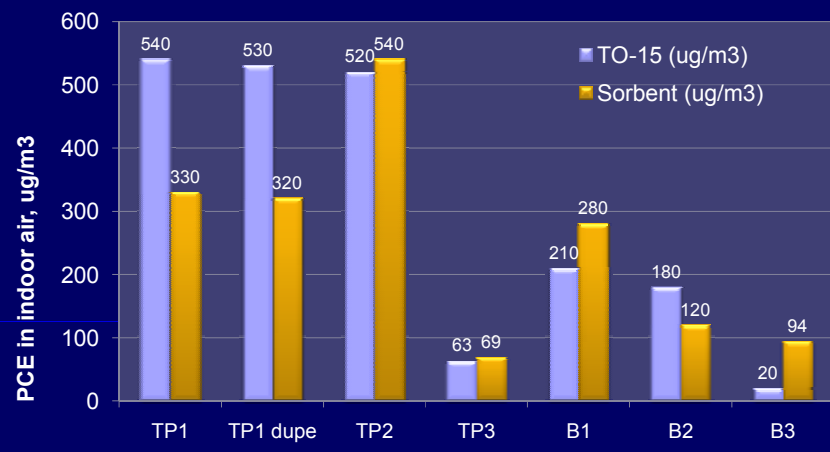
Radial Thermal Desorb Sorbent vs. TO-15 SIM



Note: Thermally desorbed sorbents are more prone to back diffusion over extended deployments which likely affected performance data in this study.

17

Sorbent Performance at Higher PCE Concentrations (commercial buildings)

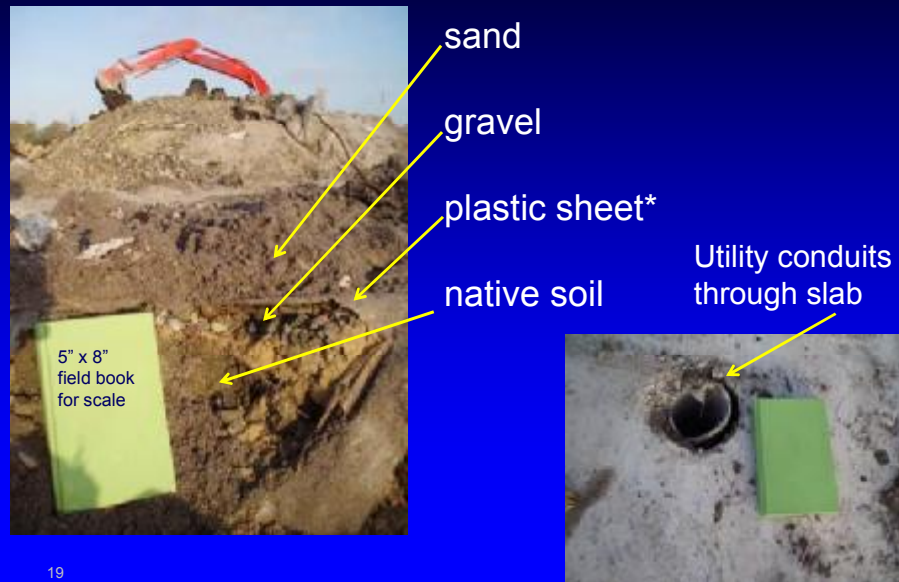


Notes: 8-hour TO-15 SIM sample vs. 14-day sorbent sample.

TP building : HVAC system off. B Building: HVAC system and roll-up doors open.

18

Orion Park Subsurface & Potential Pathways

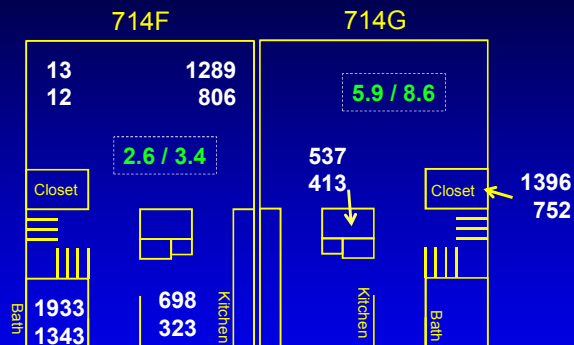


Sub-slab Soil Gas Sampling

- Small-diameter probe installed through concrete slab
- Grab sample (250 mL to 1L)
- Analyzed for VOCs by EPA Method TO-15



TCE Sub-slab /Indoor Air Results – 714F, 714G



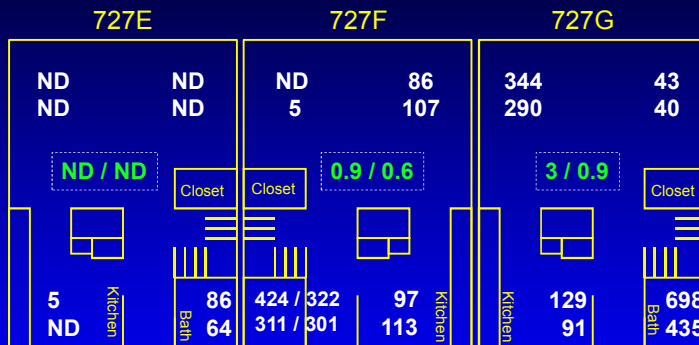
TCE concentrations in ug/m3
 1289 Subslab - Week 1 – no fan
 806 Subslab - Week 2 – no fan

2.6 / 3.4 Indoor air (TO-15 SIM); Week 1 / Week 2

21



TCE Sub-slab/Indoor Air Results – 727E, 727F, 727G



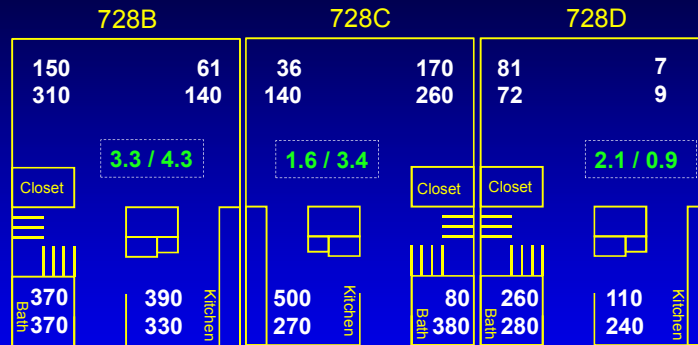
TCE concentrations in ug/m3
 86 Subslab - Week 1 – no fan
 107 Subslab - Week 2 – fan on (positive pressure)

0.9 / 0.6 Indoor air (TO-15 SIM); Week1/Week2

22



TCE Sub-slab /Indoor Air Results – 728B, 728C, 728D



TCE concentrations in ug/m3

150 Subslab - Week 1 – fan on (negative pressure)

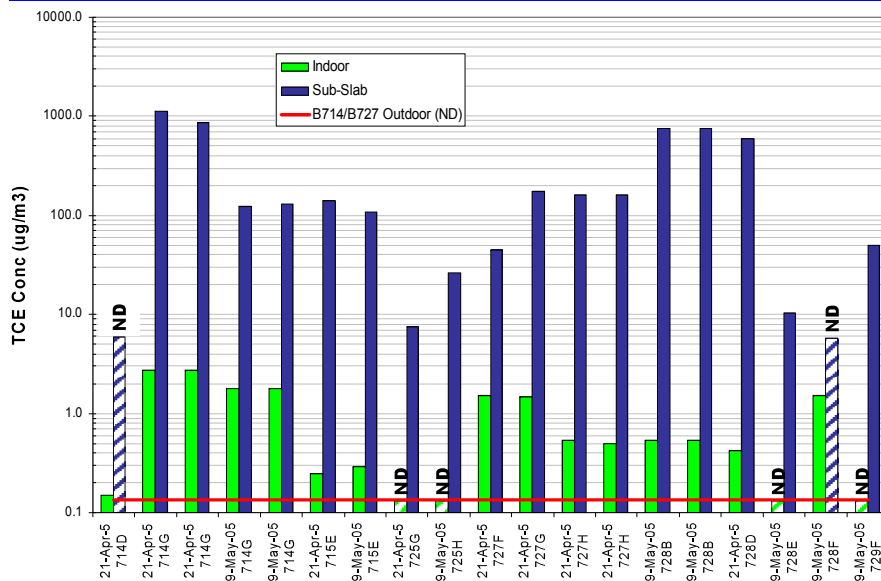
310 Subslab - Week 2 – fan off

3.3 / 4.3

Indoor air (TO-15 SIM); Week 1/Week 2



Orion Park – Single sub-slab in multiple units (TCE Sub-slab / Indoor Air)



Phases 1 and 2 - Preliminary Conclusions

- Active sorbent method provides useful air volume data, but was difficult to implement with available equipment (low-flow air pumps). Less practical compared to passive methods.
- Radial method 14-day passive solvent-extracted sorbent correlates well with 24-hour and 48-hour TO-15 SIM (canister) data.
- Radon may have applications at some sites for assessing vapor intrusion. Regardless, every home should be sampled for radon.



Key Messages

- Sorbent selection is a function of site-specific analytes, concentrations, deployment timeframe, and needed sensitivity. Be sure to establish these in project objectives.
- Appropriate sorbent type and configuration are important to ensure data quality. One size does not fit all!
- Passive sorbents can be reliable, cost-effective, and easy way to sample VOCs in indoor air as part of an indoor air vapor intrusion investigation. Another tool in the toolbox!
- Yes, it's OK to use alternative (non-EPA) methods (e.g., sorbents) if they meet project objectives (DQOs) and are acceptable to regulatory agency
- Go indoors – test the air that people are breathing!

What's Next – Ongoing Work and Upcoming Studies

- Emphasis on passive sorbent methods
- Variable sorbent deployment times (1 - 14 days)
- Common VOC analytes (low and higher concentrations)
- Commercial buildings and building pressure modification
- Homeowner deployment packaging and testing
- Testing at several Region 9 Superfund and RCRA sites



27

Acknowledgements

- EPA R9 Regional Science Council
- EPA Office of Research and Development:
 - Ron Mosley, Dale Greenwell (RTP)
 - Chris Lutes (ARCADIS)
 - Brian Schumacher, Las Vegas
- Chris Cagurangan, EPA R9 Lab
- Heidi Hayes, Air Toxics Ltd.
- EPA Site teams who volunteered and shared their Site data
- Army (Orion Park) and Navy/NASA (Moffett Field)



28



Variability in Sub-Slab TCE Vapor Concentrations in a Multi-Family Housing Complex

Katherine Baylor, Alana Lee, Mathew Plate

U.S. Environmental Protection Agency, Region 9, San Francisco, California

Primary contact: baylor.katherine@epa.gov

ABSTRACT

Sub-slab soil gas data is one line of evidence commonly used to determine the potential for subsurface vapor intrusion into an overlying building at a site. Soil gas samples from immediately beneath a building's concrete slab are analyzed for volatile organic compounds (VOCs) and when compared to empirical attenuation factors can help assess the potential for vapor intrusion to into a building exceeding a health risk-based screening level. At a former housing area at Moffett Field, California, trichloroethene (TCE) data from multiple sub-slab sample locations suggests that variability in sub-slab data may underestimate the potential vapor intrusion indoor air risk. Multiple sub-slab probes were installed in each of eight residential units (in the kitchen, bathroom, and living room). Each probe was sampled twice in September 2008. The highest TCE concentration was typically found in the bathroom sample, where sub-slab TCE concentrations were generally two to nine times higher than the living room sub-slab samples.

Study Site

The sub-slab vapor study was part of a larger vapor intrusion research project conducted at a multi-family housing complex in Moffett Field, California. All of the residences were vacant and slated for demolition, which allowed the study to be conducted under controlled conditions and unlimited access was available for the installation of sub-slab probes and changing ventilation conditions. All the residences at the study site were demolished in December 2008.

The housing complex, constructed in 1968, consisted of blocks of two-story townhomes with slab-on-grade construction (i.e., no basements). Each multi-family building block consisted of eight to ten units, with adjacent units sharing walls (Figure 1). All units within the block share a common concrete slab foundation, consisting of a slab with footers around the perimeter of the block and between each unit.



Figure 1 Aerial view of 10-unit building sampled
(GoogleEarth image)

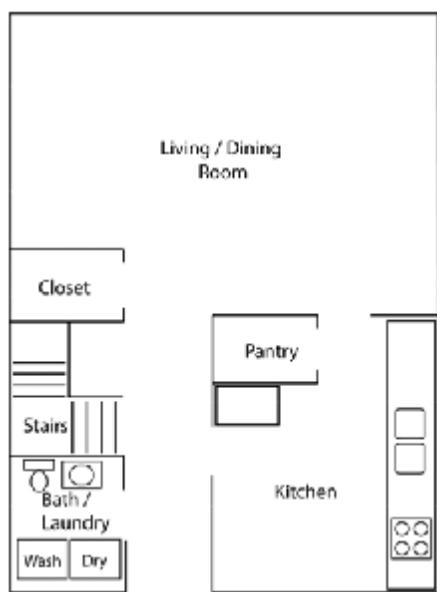


Figure 2. First Floor plan (approximately 500 square feet)

Each unit was approximately 1000 square feet (500 square feet on each of two floors). An example floorplan (first floor) is shown in Figure 2. Adjacent units have a reversed floor plan, so that kitchens or bathrooms are adjacent to each other.

The subsurface below the housing complex consists of interbedded silt, clay, and sand at the margins of San Francisco Bay. Groundwater is 5 to 10 feet below ground surface. The primary contaminant of concern is TCE in the groundwater. TCE concentrations in the shallow groundwater beneath the units tested ranged from 10 to 300 micrograms per liter ($\mu\text{g/L}$). No source of TCE in the vadose zone has been found.

Sub-Slab Probe Installation and Sampling

Sub-slab probes were installed in eight units, generally four probes per unit. Each probe extended eight inches from the top of the slab to intercept the base fill below the slab. The probes were constructed of stainless steel and brass fittings (Figure 3) and the annular space was filled with quick-set cement grout. Each probe was sampled twice in September 2008. Prior to sampling, stagnant air in the probe system was purged for three purge volumes. Samples were collected as grab samples in small-volume (250 to 500 mL) evacuated stainless steel canisters and analyzed using EPA Method TO-15 by either a commercial laboratory (Air Toxics Ltd.) or the EPA Region 9 Laboratory.

TCE soil gas sample results are shown schematically in Figure 4. In general, the highest sub-slab TCE concentrations were found in the bathrooms. Bathroom TCE sub-slab concentrations ranged from two to nearly nine times higher than the average TCE concentration in the living room.

Given that the sub-slab probe installation, purging, and sampling technique were identical for all probes, the variability in sub-slab concentrations was likely due to the greater number of subsurface utility conduits in the bathroom relative to the living room.

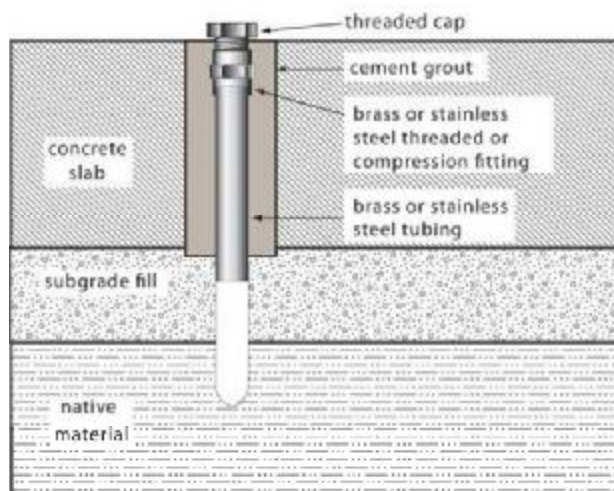


Figure 3. Sub-slab Probe Schematic

In addition to plumbing conduits for the sink and toilet, there were also utility conduits for the adjacent washer and dryer. The kitchen, which also has more subsurface conduits than the living room, had slightly higher sub-slab TCE results compared to the living room, but the effect was not as apparent as the bathrooms.

Potential preferential pathways for vapor migration associated with utility conduits include higher-transmissivity backfill surrounding the utility conduit and penetration of the conduit through the moisture barrier and the slab foundation.

Discussion

Sub-slab TCE vapor concentrations varied within each housing unit and were generally highest in the bathrooms of each residence.

Project managers who use sub-slab vapor data as the primary line of evidence in assessing the vapor intrusion pathway should consider collecting data from multiple sub-slab probe locations, and, if feasible, sampling in locations with a high network of utility conduits, such as the bathroom. As this approach is not practical at most sites, project managers may consider using indoor air data as the primary line of evidence for ensuring protection of human health. If indoor air data exceed health protective screening levels, then sub-slab vapor data could then be collected to determine if the indoor air contaminant is related to subsurface contamination.

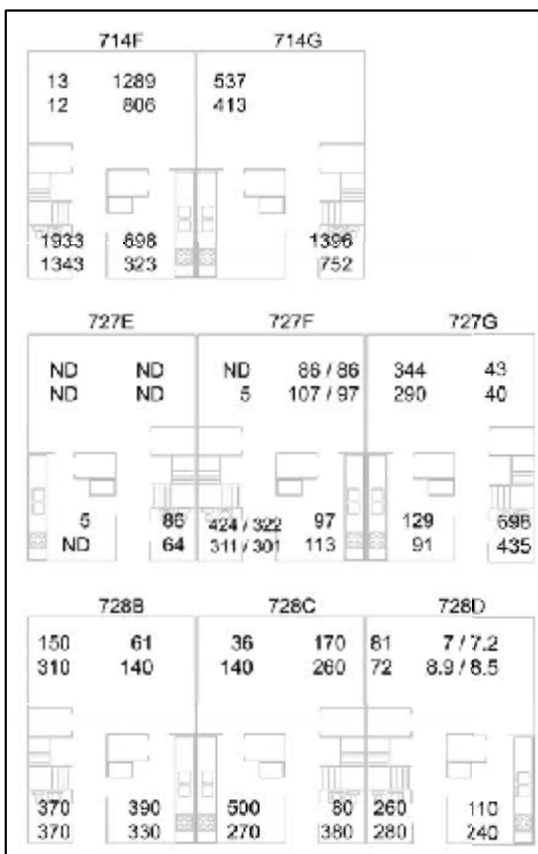


Figure 4 Sub-slab soil vapor TCE concentrations (in micrograms per cubic meter, ug/m3). Top first TCE result is the sub-slab sample collected on 9/16/08; Second TCE result is the sub-slab sample on 9/23/08. x/y samples are field duplicate samples.

Acknowledgements: Funding for this research effort was provided by an EPA Regional Applied Research Effort (RARE) grant. EPA Office of Research and Development (ORD) support provided by Dr. Ron Mosley (retired), Dr. Brian Schumacher, Dale Greenwell, Chris Lutes (ARCADIS). Significant technical assistance was provided by Heidi Hayes, Air Toxics Ltd.

Disclaimer: Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government. The views and opinions expressed herein do not necessarily state or reflect those of the United States Government, and shall not be used for advertising or product endorsement purposes.